SOP-17

Sampling for
Hydrologic Tracers

Yerington Mine Site
Standard Operating Procedure

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SOP-17
SAMPLING FOR HYDROLOGIC TRACERS

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1.0 OBJECTIVES

The objective of this standard operating procedure (SOP) is to provide the methods to be used for collecting and handling samples groundwater and surface water samples that will be analyzed for concentrations of hydrologic tracers during environmental investigations, and to provide standardized reporting formats for documentation of data. This SOP is not designed to be a stand alone document. Instead, it is to be referred to in conjunction with other SOPs prepared for the Yerington Mine Site, specifically *SOP-01: Sample Handling* and *SOP-09: Groundwater Sample Collection*.

2.0 SCOPE AND APPLICABILITY

This procedure is intended for use when, during environmental investigations, groundwater monitoring wells, domestic supply wells or surface water bodies are to be sampled and the samples analyzed for hydrologic tracers. The hydrologic tracers specifically addressed in this SOP include:

- Tritium/helium (^{3}H/^{3}He and ^{3}He:^{4}He)
- Chlorofluorocarbons (CFCs)
- Oxygen 18 (^{18}O) and deuterium (^{2}H or D)
- Sulfur isotopes (^{32}S:^{34}S and ^{18}O isotopes in dissolved sulfate)
- Nitrogen isotopes (^{14}N:^{15}N and ^{18}O in dissolved nitrate/nitrite)
- Uranium isotopes (^{234}U/ ^{238}U)

The specific hydrologic tracers may vary depending upon project-specific objectives. Sample analysis, including the analytical suite, should be discussed in project-specific planning documents (such as the QAPP or work plans).

Groundwater monitoring well installation and development will be performed in accordance with applicable SOPs and well standards for the area of the investigation; this SOP assumes that the appropriate installation and development standards have been followed. Drilling methods employed to pilot the borehole for monitoring well installation should be know as these conditions can effect sample composition. Drilling methods and domestic supply well construction information may not be known, and these conditions should be considered when evaluating data usability.

3.0 RESPONSIBILITIES

The *Project Manager* is responsible for ensuring that the project involving groundwater sampling for concentrations of hydrologic tracers is properly planned and executed and that the safety of personnel from chemical and physical hazards associated with sampling is provided for.

The *Field Scientist or Engineer* is responsible for directly overseeing the sampling of the monitoring wells and to ensuring that the project specific specifications defined in the project-specific planning documents are followed and that pertinent data are recorded on appropriate forms and in the field notebook. Monitoring well sampling will be conducted under the supervision of an appropriately qualified and registered person as defined by local regulations.

The *Site Safety Officer (SSO)*, typically the field geologist or engineer, is responsible for overseeing the health and safety of employees and for stopping work if necessary to fix unsafe conditions observed in the field. If a subcontracted firm conducts the sampling activities, then the firm will designate a site safety officer.

4.0 REQUIRED MATERIALS

The general materials required for conducting groundwater and surface water sampling for hydrologic tracer analyses are similar to those presented in SOP-09. Therefore, the field sampling team should reference SOP-09 prior to collecting any groundwater samples. This SOP provides a listing of materials specific to the sampling methods and approaches for samples submitted for tritium/helium, CFC, oxygen 18 and deuterium, sulfur isotope, nitrogen isotope, and uranium isotope analyses. The required materials, in addition to the general materials presented in SOP-09, are listed below. Additional general materials that apply to hydrologic tracer sampling and materials specific to each analyte included under this SOP are presented below.

4.1 General Materials

The following is a list of materials that should be gathered by the sampling team prior to conducting a sampling event to collect hydrologic tracer data in groundwater.

- A 2-inch electric submersible pump and/or bladder pump
- Appropriate tubing; hard plastic tubing such as polyethylene (soft tubing should be avoided, silicone or Tygon® should not be used under any circumstance)
- An adaptor allowing the sampler to connect tubing to a spigot (if domestic wells are to be sampled via spigots)

4.2 Specific Materials

The following sections provide lists of materials specific to sampling for the hydrologic tracers covered under this SOP. Because the sampling procedure is the same for oxygen

18 and deuterium, sulfur isotopes, and nitrogen isotopes, the materials specific to collecting samples for these analyses are grouped together.

4.2.1 Tritium and Helium

The following is a list of materials that will be required when sampling for tritium and helium analyses.

- 1-liter glass or high density polyethylene (HDPE) bottles with "PolySeal" caps for collecting tritium samples. Glass bottles should be used if the samples are planned to be stored for an extended periods of time (greater than one year). If breakage during shipping is a concern, the HDPE bottles should be used or the sample should be collected in duplicate (two, 1-liter glass bottles per sample location).
- Two pinch-off copper tubes (3/8-inch diameter, 30-inch length, containing about 40 cubic centimeters of water, and fitted with stainless steel pinch-off clamps at each end) per sample location.
- A back pressure valve and appropriate fittings to attach the valve to the copper tubes. Suitable parts to make the back pressure valve assembly are available through Swagelok Companies. Check local listings for suppliers of Swagelok products or equivalent several days prior to initiating the sampling event.
- A socket wrench with 13-millimeter socket.

4.2.2 Chlorofluorocarbons

The following is a list of materials that will be required when sampling for CFC analysis.

- Polyethylene tubing.
- Viton® tubing if a peristaltic pump is to be used or soft tubing is required for any other reason.
- 125 milliliter Boston round clear glass bottles (cap size: 22-400) and plastic caps with aluminum foil liner (sold separately). These bottles can be purchased through a Wheaton Industries, Inc. glass supplier and the caps through Scientific Specialties, Inc. Three bottles (with required caps) are required per sample location.
- A clean 2 to 4 liter beaker (plastic is acceptable)

4.2.3 Oxygen 18 and Deuterium, Sulfur Isotopes, and Nitrogen Isotopes

Other than the sampling bottles, collecting groundwater samples for oxygen 18 and deuterium, sulfur isotopes, and nitrogen isotopes analyses does not require specific materials not included under Section 4.1 of this SOP or SOP-09. Analyses for these hydrologic tracers require submitting five liters of sample in total. Use of 5 1-liter plastic bottles prepared by the laboratory contracted to perform the analyses is recommended. If glass bottles are used the sample will have to be collected in duplicate (10 liters in total) to account for potential breakage. The analytical laboratory performing the analyses should be contacted several days before initiating the sampling event to place a bottle order.

4.2.4 Uranium isotopes

Materials specific to sampling for uranium isotope analysis are limited to the sample bottles and disposable in-line 0.45 micron filters. The filters can be purchased from most environmental sampling supply companies. One 1-liter laboratory prepared plastic bottle should be sufficient for these analyses. The analytical laboratory scheduled to perform the analyses should be contacted several days before initiating the sampling event to place the bottle order.

5.0 METHODS

Several methods area available for collecting and handling groundwater samples for environmental investigations. Many of the general requirements of these methods apply to sampling for hydrologic tracers. However, the requirements when sampling for hydrologic tracer concentrations in groundwater are typically more stringent than requirements for other parameters. For example, these samples must be colleted using a pump because contact with the air while dispensing groundwater from a bailer will contaminate tritium and CFC samples. Therefore, a bailer will not be used to collect hydrologic tracer samples. General sampling considerations are presented in SOP-09, as well as SOP-01. These SOPs should be reviewed prior to collecting groundwater samples to be analyzed for hydrologic tracer compounds and isotopes. This SOP presents a brief summary of the general methods and outlines considerations specific to each of the analytes for which this SOP is intended. There are several good references for hydrologic tracer sampling available through the internet. It is recommended that the filed sampling team review the websites listed in Section 8.0 of this SOP.

5.1 General Considerations

Good communication is essential to the ultimate success of a groundwater and surface water sampling project. This includes communication within the project team, as well as communication with the client and analytical laboratory, when establishing project objectives. Good communication with the project team, laboratory, client, and, if appropriate, regulatory agencies, includes complete project specific planning documents such as field sampling plans, quality assurance plans, and scope of work documents for subcontracted laboratories. Plans should include detailed information with respect to site-specific requirements, with reference to SOPs wherever possible, and risk criteria that will be used to assess the data.

In addition to good communication, the project plans should consider equipment decontamination, sampling equipment, sampling sequence, and field quality assurance/quality control (QA/QC) samples. These are described in the following sections.

Another key general consideration is the different procedures for sampling surface water and groundwater. Groundwater sampling involves two primary operations: the purging of stagnant water from the well and the collection of a sample that eliminates contact with the atmosphere. Groundwater sampling variables can be significantly controlled through the appropriate selection and use of purging and sampling equipment, and through the use of procedures that are described below. Because surface water is already in contact with the atmosphere, considerations for collecting surface water samples are largely focused on eliminating atmospheric contact after the sample has been containerized.

5.1.1 Equipment Decontamination

Equipment that will be in contact with the sample must be decontaminated prior to and/or after each use. This is necessary to minimize inadvertent contamination of the sample. Specific methods for equipment cleaning are dependent upon a number of factors including the sample media, analytical parameters, the purpose of the investigation, the equipment to be cleaned, and the specific regulatory guidelines that may apply. Equipment decontamination procedures are described in *SOP-05 Decontamination*. Any site specific decontamination procedures can be specified in the field sampling plan for each project.

5.1.2 Dedicated and Disposable Equipment

Use of dedicated and new, disposable purging and sampling equipment are preferable to decontamination of reusable sampling equipment. Dedicated equipment, and use of new, disposable equipment, can virtually eliminate cross-contamination between samples caused by incomplete decontamination. Dedicated equipment can also increase sampling efficiency through the elimination of the need to decontaminate equipment for successive sampling. Furthermore, dedicated equipment can also help to reduce the physical handling of the equipment that can cause sample contamination through contact with potentially contaminated surfaces. New, disposable equipment may need to be decontaminated before use. Review project-specific planning documents regarding decontamination of disposable equipment.

5.1.3 Sequence of Sampling

The groundwater sampling operation should always be conducted in a sequence that proceeds from wells containing the lowest concentrations to wells containing the highest concentrations. Sampling in this order will minimize the likelihood of sample cross-contamination that can be caused through improper handling or equipment cleaning. This type of sampling sequence should be used even for programs in which equipment is dedicated to minimize the cross-contamination that could result from exposure to contaminated garments or other equipment. If water quality is not known, the wells up-gradient of a suspected source area should be sampled first, followed by the wells furthest away and cross-gradient or down-gradient.

Sampling sequence also applies to the order that different analytes are collected. Typically these analytes that are volatile are collected first, followed by those that are sensitive to oxidation. The hydrologic tracers for which this SOP is intended should be collected in the following sequence:

1) Tritium and Helium
2) Chlorofluorocarbons
3) Oxygen 18 and deuterium
4) Nitrogen isotopes
5) Sulfur isotopes
6) Uranium isotopes

5.1.4 Purging and Sampling Procedures

This section provides a summary of the procedures to be used for groundwater sampling. These procedures include planning, preparatory office activities, preparatory field activities, well purging, well sampling, and post sampling activities. These activities are described in detail in SOP-09.

Planning. The planning phase should include the selection of specific field methods, including the well purging strategy and planning for the proper disposal of the purge water. The sampling program should be discussed in project-specific planning documents. Good communication with the analytical laboratory is essential to the success of a water sampling project. The analytical requirements must be well defined and clearly communicated, prior to conducting the field work. Written communication is encouraged, in particular to document requirements for specific analytical methods, detection limits, and other special needs.

Purging and Sampling Equipment Selection should consider:

- Well yield

- Depth to water
- Well diameter and depth
- Required material of construction
- Analytical parameters
- Regulatory requirements
- Cost

Attachments B and C of SOP-09 of the project QAPP summarize well sampling equipment and present a matrix indicating suitability of sampling and purging equipment for specific applications. Bailers will not be used while sampling for hydrologic tracers. Based on the data presented in Attachments B and C of SOP-09, purging and sampling must be done using either a bladder pump or a 2-inch electrical submersible pump when collecting samples for hydrologic tracer analyses.

Several different strategies are commonly used in order to assess the completeness of monitoring well purging. The strategies that may be applied to hydrologic tracer sampling are listed below.

1) Purging is continued until stabilization of certain indicator parameters is observed in successive measurements over a specified time or volume. The most commonly used indicator parameters include pH, specific conductivity, turbidity, temperature, oxidation/reduction potential (ORP), and dissolved oxygen (DO).
2) Purging 3 to 5 well volumes of water from the well.
3) Purging until the well is dry and allowing the well to partially recover (often 12 to 24 hours)
4) Low or no-flow purging strategies. Generally, well is pumped at rates (<0.5 gallons per minute) that do not induce drawdown and ostensibly mirror flow rates in the aquifer.

Monitoring wells should be purged using one of the methods listed above. These methods are described in detail in SOP-09. Sampling of domestic wells, where lowering a pump directly into the well is not possible, should be purged by opening the spigot and allowing a pre-determined amount of water (e.g., 20 gallons) to flow through. Purging of domestic wells is then continued until indicator parameters (pH, specific conductivity, etc) have stabilized. For the majority of the hydrologic tracers, sampling must be completed using tubing, therefore, an adapter to connect the spigot to the tubing will be required.

The methods and responsibility for collection, containerization, treatment and disposal of purge water should be determined prior to initiation of any sampling project. Handling purge water is discussed in *SOP-06: Investigation Derived Waste*.

Preparatory Office Activities. Equipment and containers should be organized in the office prior to embarking on a field sampling project to the extent practicable. The time spent in the field should be spent on sample collection, making field measurements, and recording data.

The purging and sample collection equipment and all required hardware (Section 4.0 of this SOP) should be obtained, organized and decontaminated prior to the initiation of the field sampling program. To accommodate waste generated during decontamination, these activities may be completed at the site prior to sampling.

The appropriate sample containers and associated preservatives must be obtained (Section 4.0 of this SOP). The containers and preservatives are normally, but not always, supplied by the laboratory that will be responsible for the analyses. Sample containers specific to hydrologic tracers (tritium and helium isotopes) must be purchased from specific vendors (Section 4.0 of this SOP) prior to implementing the field activities. Sample containers should be organized and inventoried several days prior to the sampling program in order to provide sufficient time to rectify any problems, should they occur. Whenever possible, pre-printed sample labels should be created prior to mobilization.

Field data sheets should be initiated prior to the start of sampling. Examples of initial data to be recorded include site and sampling location identification, well depth and construction, and purging and sampling collection methods. Additional discussion regarding field records is presented in Sections 5.0 through 7.0 of this SOP as well as within SOPs on Sampling Handling (SOP-01), Sample Preservation (SOP-02), and Field Notes and Documentation (SOP-03).

For domestic wells or monitoring wells that are located on property not owned by the client, landowners must be notified prior to sampling. The notification should be at least several days prior to the sampling event and should include the specific date and times that personnel will be on the property. Additional procedures that should be followed when notifying a landowner that groundwater sampling will be conducted on their property are presented in SOP-09.

The field sampling team should be familiar with all applicable SOPs presented in Appendix E of the Yerington Mine Site QAPP, several days prior to initialing the sampling event.

Preparatory Field Activities. The following summarizes procedures that should be conducted in the field prior to well purging and sampling. For a more detailed discussion of preparatory field activities, please refer to SOP-09.

- *Check the Well Maintenance/Condition.* A well maintenance/condition check should be performed that includes a visual inspection of the condition of the protective casing and surface seal. In addition, the well should be inspected for other signs of damage or unauthorized entry. Any problems should be documented.

- *Establish the Well Depth.* Where possible, well depths should obtained from well completion records. The well depth should be sounded only if necessary to verify the depth; for example if you suspect that sediment/soil has collected in the bottom of the well or if well completion records are not available.
- *Prepare the Well Area.* A suitable work area should be established around the perimeter of the well. Sampling equipment should be placed on a clean surface such that it will not become inadvertently contaminated.
- *Measure the Static Water Level.* The depth to water should be measured prior to initiation of all sampling activities.
- *Calculate the Well Purge Volume.* The volume of water standing in the well should be calculated through the application of the depth to water data, the well depth, and the well diameter using the constants presented in SOP-09, or alternatively, the well casing volume may be calculated using the formula V = CF*d2h, where; V is volume of water (gallons),d is the diameter of well (inches), h is the height of water column (feet), and CF is the conversion factor (0.0408) that includes conversion of cubic feet to gallons, inches to feet, and diameter to radius.

5.2 Specific Considerations

The specific considerations for each of the hydrologic tracers for which this SOP is intended (tritium/helium, CFCs, oxygen 18 and deuterium, nitrogen isotopes, sulfur isotopes, and uranium isotopes) are presented below. The sampling procedure is the same for collection of samples to be analyzed for oxygen 18 and deuterium, nitrogen isotopes, and sulfur isotopes concentrations/isotopic ratios and therefore, these hydrologic tracers are grouped together in this section of the SOP. All of these samples should be safely packaged on ice within a cooler and stored at 4 degrees Celsius or less once the sample has been properly collected.

5.2.1 Tritium and Helium

Considerations specific to sampling for determining the Tritium and Helium concentrations as well as the $^{3}He:^{4}He$ isotopic ratio, are described below.

Collecting Groundwater Samples for Tritium Analysis. Indoor air water vapor tritium concentrations can be several orders of magnitude greater than typical atmospheric conditions due to the presence of various luminescent dials; therefore, these samples should always be collected outdoors. This consideration is particularly important when collecting samples from domestic wells via home spigots. Also, because luminescent dials or back lights may be present, the person performing the sample transfer is not allowed to wear a wristwatch, compass or similar item.

At least one liter of groundwater should be collected for tritium analysis. The field team may use either glass or HDPE bottles with "PolySeal" caps to collect these samples. The analytical laboratory should be contacted several days before initiation of the field activities and asked to provide new, clean bottles. If glass bottles are selected and the samples are to be shipped, a duplicate should be collected at each location (in case of breakage). Fill the bottle not quite to the neck with sample, leaving some air space. Do not rinse or overfill the bottles. Make sure the cap is screwed on tightly. Do not add anything (fore example, preservative) to the water sample. The samples should be stored at or below 4 degrees Celsius; however, freezing should be avoided.

Collecting Groundwater Samples for Helium Analysis. Collecting groundwater samples to be submitted for helium analysis is considerably more complicated than collecting groundwater to be submitted for tritium analysis. Helium samples will be submitted to the analytical laboratory in a special copper sample tube, in duplicate. These samples will be analyzed for their helium concentration and determination of the ^3He:^4He isotopic ratio (δ3He) of dissolved helium.

The water samples for helium determinations are collected in special pinch-off copper tubes (3/8-inch diameter, 30-inch length, containing about 40 cc of water, and fitted with stainless steel pinch-off clamps at each end). Lamont-Doherty Earth Observatory (IDEO) should be contacted several days before initiation of the sampling event to obtain the sample tubes. It is likely that the samples will also be submitted to IDEO for analyses. The project will be billed a $50.00 deposit for each copper sample tube. The deposit will be refunded when the samples are submitted for analysis and/or unused sample tubes are returned to the contract laboratory, in the same condition they were received.

To collect the samples, remove and discard the plastic caps that cover the ends of the copper tube, taking care not to scratch or damage the ends of the copper tube. Connect the copper tube to the tubing from the pump or spigot. The connections should be airtight and caution should be taken to ensure will not come loose when back pressure is applied during closing of the copper tubes. Making this connection using clear plastic tubing (such as polyethylene) is preferred so that sampling personnel can visually observe whether air bubbles are present in the water line. These connections should be secured with stainless steel hose clamps, again being careful not to damage the end of the copper tube. The length of the path from the well or pump discharge should not exceed about 5 feet to minimize the possibility of gas separation from the water sample prior to sealing the copper tube.

Any trapped air or formation of gas bubbles in the helium water sample will produce erroneous results. Therefore, back pressure will be normally applied to the discharge end of the copper tube during flushing. To establish the back pressure, a small valve and appropriate fittings to attach the valve to the discharge end of the copper tube will be required. Again, clear plastic, allowing field personnel to observe if bubbles are present in the line, should be used in making the copper tube-back pressure valve connection. Both water flow and back pressure on the sample should be increased if gas bubbles are forming. However, the back pressure valve should not be closed completely. A steady flow of water must be maintained through the copper tube; however, the back-pressure applied must exceed the internal pressure of the dissolved gases in the water sample. Flushing of the copper tube can be accomplished in five minutes or less.

The sample will be contained by closing the pinch-off clamps at either end of the copper tubes. First tap the line from the well to the copper tube forcibly to dislodge any gas bubbles. While tapping, the copper tube should be held at an approximate 45-degree angle with discharge pointing up. Once gas bubbles can no longer be observed in the line from the well (or spigot) or in the plastic tubing used to connect the back pressure valve, you are ready to collect the sample.

A socket wrench with 13-mmsocket is used to turn the bolts that close the pinch-off clamps. Position the copper tube in the approximate center of the pinch-off clamps. Begin with the bolts at the discharge end; alternate turning the two bolts on each clamp so that the blades of the clamp close evenly. The pinch-off clamps are machined to leave about a 1-millimeter space when the bolts are turned all the way down; however, care should be taken not to over tighten and strip the threads on the bolts. After tightening the discharge end bolts, tighten the upstream bolts in the same manner. Make sure that the copper tube is still centered across the blades of the clamp. Before disconnecting the copper tube from the well discharge line, double check to be sure that all bolts are tight. Remove the back-pressure valve from the discharge end of the copper tube.

A preservative is not required to be added to these sample containers.

5.2.2 Chlorofluorocarbons

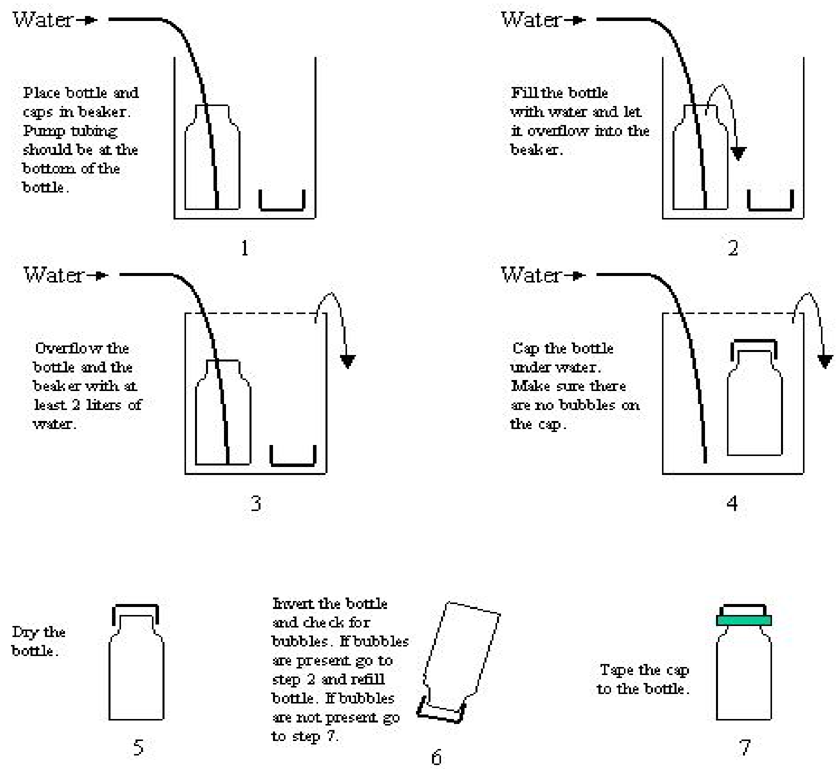
Groundwater samples submitted for CFC analysis must be transferred to the sampling container via tubing; in other words, pumped from wells or, if domestic wells are to be sampled from spigots, transferred from spigots without contacting the ambient air. Using bailers to collect groundwater samples from wells will give unacceptable results because the sample will become contaminated with by CFCs present in ambient air as the sample is transferred from the bailer to the sample container. Most plastic materials will also contaminate a water sample because small amounts of plastizers (containing CFCs) will leach into the water sample. Therefore glass bottles are required. Because of the potential for sample contamination from plastics, if soft tubing is necessary, Viton® tubing should be acquired; using silicone or Tygon® tubing will contaminate the sample. Hard polyethylene tubing should not contaminate the sample is preferred whenever possible. To further prevent sample contamination, lubricants (such as oils, greases, or sprays) should not be used to maintain the pump or any other sampling equipment and field personnel should not apply insect repellent.

The samples must be collected in 125 milliliter Boston round clear glass bottles using only aluminum lined caps. The caps have to be purchased separately from the bottles. Discard any caps with foil liners that appear scratched or damaged.

The bottles and caps should be thoroughly rinsed using the water to be sampled. The bottles are filled and capped underwater in a beaker. Refrigeration-grade copper, polyethylene, polypropylene, Viton® or polyurethane pump tubing is required. Again, most soft flexible tubing (such as silicone Tygon® or silicone) will contaminate the sample. The filling procedure is carried out within a clean two to four liter beaker. A plastic beaker is acceptable. Fill a minimum of 3 bottles per sample.

The procedure is shown below and is as follows (refer to the figure below):

Place the bottle in the beaker. Insert the tubing from the pump into the sample bottle so that discharge occurs at the bottom of the bottle. Also place all the three caps in the beaker. Fill the bottle until it overflows. Continue to overflow the bottle until it is completely submerged inside the beaker and the beaker is also overflowing. Allow at least 2 liters of water to flow through the bottle and out of the beaker. Select a cap from the bottom of the beaker and tap it under water to dislodge air bubbles. Remove the pump tube from the bottle and cap the bottle while it is still underwater. The water in the bottle must not come in contact with air. Make sure the cap is sealed tightly and remove the bottle from the beaker. Dry the bottle. Invert the bottle, tap it and check it for air bubbles. If there are bubbles, re-submerge the bottle, remove the cap, and begin pumping water through the sample bottle again. Allow another two liters to flow through the bottle and out of the beaker before attempting to recap the bottle. If it is necessary to refill the bottle, you must use a new cap.



Once it is confirmed that gas bubbles are not present in the bottle, securely tape the cap to the bottle with electrical tape. Wrap the tape in a clockwise direction looking down at the bottle top. Label each bottle with the well name, date, time of sampling, and the sequence number of each bottle as it was collected (one through three).

CFC analysis should not be performed on samples stored for over six months. Preservative is not required.

5.2.3 Oxygen 18 and Deuterium, Sulfur Isotopes, and Nitrogen Isotopes

These samples can be collected following the general sampling procedures outlined in SOP-09. The polyethylene tubing extending from the well head or the spigot (in the case of domestic wells) can be held over the sample bottle and allowed to cascade into the bottle. If glass bottles are used, some air should be allowed to remain in the bottle to prevent breakage from sample expansion as it cools during storage. The analyses for nitrogen isotopes is particularly sensitive to the total mass of nitrogen in the sample. Thus, if available, historic nitrogen concentration data can be used to calculate the amount of water sampled needed to meet laboratory analytical requirements. Alternatively, a total of five liters should be collected to ensure sufficient sample is provided to the laboratory for these analyses. Using plastic 1-liter bottles is recommended over glass bottles because of the quantity of sample that would be collected (duplicate) to compensate for potential sample bottle breakage during travel. Preservative is not required

5.2.4 Uranium Isotopes

Collecting samples for uranium isotope analyses is, for the most part, also in accordance with the generals sampling protocol presented in SOP-09. These samples are collected as you would any other dissolved metals sample; filtering the sample as it is collected using in-line disposable filters. The polyethylene tubing extending from the well or spigot (in the case of domestic well sampling) must be attached to an inline 0.45 micron filter and the filter's outflow then held over the sample bottle. Groundwater can be pumped up from the well, through the filter, and allowed to cascade into the sampling container. Each filter should only be used once before being disposed. It may be necessary to use more than one filter per sample location depending on the amount of solids suspended in the water (filters may clog). Preservative is not required for uranium isotope analysis.

5.3 Sample Handling and Shipping Methods

Please refer to *SOP-01: Sample Handling* for a complete discussion of the sample handling protocol for this project.

Shipment of samples is also discussed in detail in SOP-01. Proper packaging is necessary in order to protect the sample containers, to maintain the samples at or below a temperature of 4 degrees Celsius, and to comply with all applicable transportation regulations. It is likely that several laboratories will be used to perform the various hydrologic tracer analyses; therefore, it is very important that care is taken to ensure each sample cooler is accompanied by the appropriate documentation.

Sample handling procedures specific to groundwater samples to be submitted for hydrologic tracers analyses are limited to:

- Taking precautions not to scratch or otherwise damage the ends of the copper tubes used for sampling for helium analysis. If the sample waters are believed to be corrosive, the ends of the copper tubes should be rinsed with clean water.

- Making sure the caps on bottles to be submitted for CFC analysis are tightly taped with electrical tape.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

In order to assess the accuracy and precision of the field methods and laboratory analytical procedures, quality assurance/quality control (QA/QC) samples will be collected during the sampling program according to the requirements of the project QAPP and Work Plan. QA/QC samples may be labeled with QA/QC identification numbers or fictitious identification numbers if blind submittal is desired, and are sent to the laboratory with the other samples for analyses. The frequency, types, and locations of QA/QC samples are specified in the project QAPP or Work Plan. Examples of QA samples include, but are not limited to, equipment rinsate blanks, field blanks, trip blanks, duplicate samples, and matrix spike/matrix spike duplicate samples. These examples are described in detail in SOP-09. The frequency and type of QA/QC samples collected during groundwater sampling for hydrologic tracer analyses should be the same as required for other (such as target contaminant) analyses. QA/QC samples are collect by the same methods described in this SOP.

7.0 RECORDS

Field notes and logs will be submitted to the Project Manager or designate immediately following the field event for checking and revision purposes. The Project Manager or designate shall review and transmit the completed forms for incorporation into the project file.

8.0 REFERENCES

United States Department of the Interior; U.S. Geological Survey Website, Last Modified: Thursday, 28-Sep-2006 11:51:43 EDT. URL: http://water.usgs.gov/lab/. Page Contact Ken Dreyer.

The Tritium Laboratory; University of Miami/RSMAS Website, Last Revised: March 31, 2006. URL: http://www.rsmas.miami.edu/groups/tritium/prices.html.

Dr. Allan Jefferies, Zymax Envirotechnologies, Inc. February 22, 2006. Telephone conversation discussing sample collection procedures.